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ABSTRACT

This second in a series of six modules for a course titled Civil/Structural Inspection describes the materials used in structural steel work: the standards according to which materials are purchased and inspected: fabrication, handling, and installation practices: and the various inspection tasks performed during erection operations. The module follows a typical format that includes the following sections: (1) introduction, (2) module prerequisites, (3) objectives, (4) notes to instructor/student, (5) subject matter, (6) materials needed, (7) procedures, (8) data table, (9) reference materials, (10) test. (The course is one of fifteen technical courses for the second year of a two-year postsecondary curriculum in Nuclear Quality Assurance/Quality Control Technology.) (LRA)

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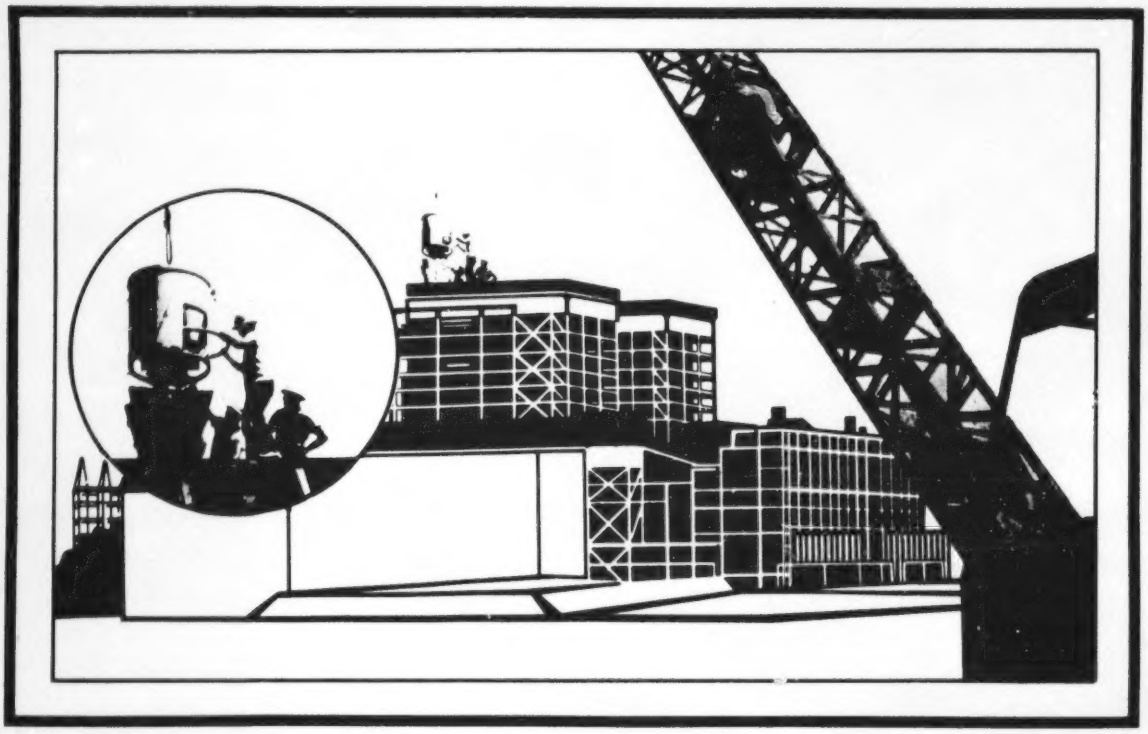
NUCLEAR TECHNOLOGY

COURSE 29 CIVIL/STRUCTURAL INSPECTION

MODULE 29-2 Structural Steel Materials, Installation and Inspection



CE 0247272

GENERAL PHYSICS CORPORATION
Columbia , Maryland

COURSE MODULES

COURSE 29 CIVIL/STRUCTURAL INSPECTION

Module 29-1	Inspection of Construction Operations
Module 29-2	Structural Steel Materials, Installation, and Inspection
Module 29-3	Concrete Materials
Module 29-4	Concrete Preparation, Production, Placement and Finishing
Module 29-5	Concrete Testing and Inspection
Module 29-6	Prestressed Concrete Materials, Fabrication, and Inspection

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This module was prepared for General Physics Corporation by Richard Groseclose, General Physics Corporation.

GENERAL PHYSICS CORPORATION

1979

INTRODUCTION

On large construction projects, a qualified QA/QC technician functions as a structural steel inspector and is responsible for materials acceptance and installation inspection. The term structural steel is used to describe steel columns, beams, girders, trusses and other structural units used in building and bridge construction. Structural steel members are fabricated by riveting, welding, or bolting together various types of rolled steel shapes or sections, such as channels, H-beams, angles and tees.

This module describes the materials used in structural steel work; the standards to which materials are purchased and inspected; fabrication, handling and installation practices; and the various inspection tasks performed during erection operations.

MODULE PREREQUISITES

The student/trainee should have prior training or experience in inspection of construction operations. Completion of Module 29-1, Inspection of Construction Operations, satisfies this prerequisite.

OBJECTIVES

Upon completion of this module, the student/trainee can:

1. Demonstrate a knowledge of structural steel materials and specifications requirements by performing the following:
   a. Given sample chemical and physical test reports on specimens representing two types of structural steel materials, (1) compare reported results with given specification requirements, (2) identify nonconforming characteristics, and (3) determine the acceptability of the materials.
   b. Given the inspection results for a group of steel shapes inspected for straightness, (1) compare the results with specification requirements, (2) calculate the permissible camber for each member, and (3) determine the acceptability of each member.
2. Identify the basic members of a simple structural steel roof support structure.
3. Describe methods of cutting steel parts and preparing bolt holes.
4. State the purpose of temporary protective coatings on steel members.
5. Describe site storage conditions for steel members.
6. Describe alignment techniques of members for erection.
7. Describe riveting operations.
8. Describe "turn-of-nut" method of tensioning of high-strength bolts.
9. Name the structural steel welding specification.
10. Describe receipt-inspection operations including the basic examinations performed, purpose of test reports, and how acceptability of material test reports is determined.
11. Describe final inspection of bolted fasteners including sample size and actions taken when acceptance criteria are not met.

MATERIALS STANDARDS

Chemicals and Physicals

Structural steel shapes are normally supplied by the steel manufacturers to a quality grade known as "structural quality". The type of steel most commonly used for structural purposes is a carbon steel specified as American Society for Testing and Materials (ASTM) A36, Standard Specification for Structural Steel. A36 steel has high strength, high ductility, great stiffness, and is highly resistant to wear and abrasion. A36 steel, on the other hand, rusts readily in damp or corrosive environments, and loses strength and stiffness at high temperatures (i.e., above 800°F.)

ASTM Standard A36 specifies chemical and physical requirements for the material. For structural shapes, the chemical and physical requirements for A36 steel are listed in Tables 29-2-1 and 29-2-2:

TABLE 29-2-1. ASTM A36 Steel, Chemical Requirements

Carbon, max. %	0.26
Phosphorous, max. %	0.04
Sulfur, max. %	0.05
Copper, min. % (when copper steel is specified)	0.02

TABLE 29-2-2. ASTM A36 Steel, Physical (Tensile) Requirements

Tensile strength, psi	58,000 - 80,000
Yield point, psi	36,000
Elongation in 8 in., min. %	20
Elongation in 2 in., min. %	21

For structural applications requiring a higher strength material, ASTM A529 steel may be used. A529 steel has a 42,000 psi minimum yield strength, as compared to 36,000 psi for the A36 steel. The chemical and physical requirements for A529 steel are shown in Tables 29-2-3 and 29-3-4.

TABLE 29-2-3. ASTM A529 Steel, Chemical Requirements

Carbon, max. %	0.27
Manganese, max. %	1.20
Phosphorous, max. %	0.04
Sulfur, max. %	0.05
Copper, min. % (when copper steel is specified)	0.20

TABLE 29-2-4. ASTM A529 Steel, Physical (Tensile) Requirements

Tensile strength, psi	60,000 to 85,000
Yield point, psi	42,000
Elongation in 8 in., min. %	19

For either material, A36 or A529, the steel shapes may be purchased to the chemical composition limits, or the mechanical property requirements, or both, as required by the applicable engineering specifications for the particular construction job.

The standard hot-rolled steel shapes are illustrated and described in Figure 29-2-1.

Dimensions and Fasteners

The general dimensional requirements for structural steel shapes are covered in ASTM A6, Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use. This specification provides dimensional acceptance criteria for structural shapes and other structural steel materials, and defines permissible variations. The variations in the finished mill products result from such factors as roll wear, subsequent roll dressing, and temperature variations in the steel materials and rolling equipment.

W Shapes

W shapes have essentially parallel flange surfaces. The profile of a W shape of a given nominal depth and weight available from different producers is essentially the same except for the size of fillets between the web and flange.

HP Shapes

HP shapes (used for bearing piles) have essentially parallel flange surfaces and equal web and flange thicknesses. The profile of an HP shape of a given nominal depth and weight available from different producers is essentially the same.

C Shapes (American Standard Channels)

S Shapes

C shapes and S shapes have a slope of approximately 16-2/3% (2 in 12 inches) on their inner flange surfaces. The profiles of C and S shapes of a given nominal depth and weight available from different producers are essentially the same.

M Shapes

M shapes are those which are similar to, but cannot be classified as W, HP, or S shapes.

MC Shapes (Miscellaneous Channels)

MC shapes are channels which are similar to, but cannot be classified as American Standard Channels.

Angles Equal Legs

Angles Unequal Legs

Equal leg and unequal leg angle (L) shapes of the same nominal size from different producers have profiles which are essentially the same, except for the size of the fillet between the legs, and the shape of the ends of the legs.

Structural Tees- Cut from W Shapes

Structural Tees- Cut from S Shapes

Figure 29-2-1. Standard Structural Steel Shapes*

* From American Institute of Steel Construction (AISC)

Two types of mechanical fasteners are used in fabricating structural steel members: high strength steel bolts, and steel structural rivets.

The bolts generally used are heavy hex structural bolts, manufactured to ASTM types A325 and A490. A325 bolts are fabricated from steel having a minimum tensile strength of 105,000 psi and minimum yield strength of 81,000 psi. The A490 bolts are quenched and tempered alloy steel bolts fabricated from steel having a minimum tensile strength of 150,000 psi and minimum yield strength of 130,000 psi.

The bolts and nuts are illustrated in Figure 29-2-2, with dimensions listed in Table 29-2-5. A325 bolts are identified on top of the head by three radial lines, the legend "A325", and the manufacturer's symbol. A325 nuts are identified on at least one face by three circumferential marks, or by the number "2", "2H", "D" or "DH" and the manufacturer's mark.

A490 bolts are marked with the legend "A490" and the manufacturer's symbol. Heavy hex nuts for use on A490 bolts are identified with the legend "2H" or "DH" and the manufacturer's mark. A490 bolts may be substituted for A325 bolts, if expedient on the basis of availability, in which case the tension (when tightened) need not exceed that required for the A325 bolts.

Heavy hex structural bolts have shorter thread lengths than other standard bolts. They are selected for use to exclude the thread from all shear planes except in the case of thin outside parts adjacent to the nut, thereby maximizing the shear-working strength of the fastener.

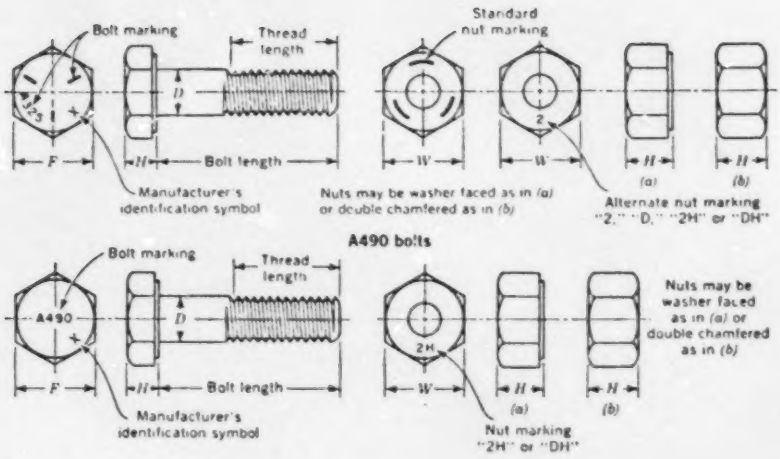


Figure 29-2-2. Heavy Hex Structural Bolts

TABLE 29-2-5. Structural Bolt Dimensions

Nominal bolt size, *D*	Bolt Dimensions, In Inches			Nut Dimensions, In Inches	
	Heavy Hex Structural Bolts			Heavy Hex Nuts	
	Width across flats *F*	Height *H*	Thread Length	Width across Flats *W*	Height *H*
1/2	7/8	5/16	1	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 13/16	1 7/64
1 1/4	2	25/32	2	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 3/8	1 15/32

The rivets generally used are made to ASTM standard A502 in three grades. Grade I rivets are carbon steel which are for general purposes; Grade II rivets are carbon-manganese steel which are suitable for fastening high-strength steels; and Grade III rivets are similar to Grade II, but with enhanced atmospheric corrosion resistance.

Any of these fasteners are normally purchased to the applicable ASTM requirements, and are furnished with manufacturers' certifications that they meet or exceed all such requirements.

FABRICATION OF COMPONENTS

Structural steel components or members are usually assembled in fabricating shops from standard plates and shapes before being shipped to the construction site.

One of the most common types of prefabricated steel members is the truss. Trusses are triangular shaped modules connected into a structural framework used to span large areas without intermediate support (supported at ends only). Large trusses may be shipped to the job site in sections, and are usually preassembled before erection.

Trusses may be interconnected with relatively light weight members called purlins. Roof support systems are frequently comprised of trusses and purlins.

The operations performed in the fabricating shop in constructing such members begins with laying-out the required parts on plate materials or shapes, and cutting or shearing to correct shape and length. Steel is cut with an oxyacetylene cutting torch or sheared with a mechanical cutting device with a large blade that drops onto the steel to shear it to the proper length. If smoother ends are needed, the cut or sheared surfaces are finished by planing or grinding to a smooth surface. Holes for rivets or bolts are typically drilled. Holes may also be punched and then reamed smooth to provide accurate fastener fit. If connections are to be made by welding, the work is partially done in the shop by "weld-prepping" the member ends (i.e., cutting or grinding

the joint surfaces to the correct configuration and size). As a general rule, a maximum amount of work is performed in the shop, to minimize and simplify the riveting, bolting, and welding required at the erection site.

HANDLING AND STORAGE

Prefabricated steel members are usually shop-coated with a light, protective coat of paint to protect the steel until it has been erected and finish-coated or embedded in concrete. Normally the requirement for such painting is written into the purchase specification. Rust and scale should be removed from the members to provide a good bonding surface, followed by the application of an even, uniform coat of paint. If the steel is not coated in this manner, it must be protected from moisture from all sources. Carbon steels rust or oxidize rapidly in the presence of moisture, salt air, or industrial air pollution. The rust is formed from the solid metal, and gradually reduces the size and strength of the member with the passage of time. Uncoated steel members should be stored on cribbing under cover of a roof or tarpaulins to avoid such deterioration. Coated materials should be examined, and, if in good condition with no abraded or exposed areas, may be stored outdoors on cribbing.

Structural steel members are generally fabricated to precise designs for supporting specific loads in specific directions. Since most parts are prefabricated in shops for assembly and erection in the field, they are also fabricated precisely with respect to size and bolting-hole locations. Such members may be rendered unusable if bent, twisted or deformed from overstressing. Consequently, much

care must be exercised in unloading and handling members; dropping or impact-loading members can result in kinks, misalignment and deformation.

STRUCTURAL STEEL ERECTION

Before actual erection work begins, all prefabricated members are checked against the applicable shop drawing. The following characteristics are examined, as applicable:

- member straightness, size and configuration
- surface preparation and coating
- milling of column ends
- bolt hole sizes, number, and layout
- finishing of sheared or flame-cut edges
- preparation of edges or surfaces to be welded

The erection site should also be inspected to verify that all preparations for the erection work have been completed. These preparations include the following:

- all required anchor bolts are located and installed correctly
- adequate bracing materials are on hand
- adequate tools and equipment are on hand
- proper fasteners are on hand, in adequate quantity

The erection of steel building skeletons or steel for other structural applications usually begins with the setting and bolting of columns (vertical members). Framing must be carried up true and plumb, and temporary bracing must be used whenever necessary to take care of all loads to which the structure may be subjected (wind, construction materials, erection equipment, etc). As erection progresses, the work is securely fastened to take care of all dead load,

wind and erection stresses. No permanent fastening is done, however, until as much of the structure as will be stiffened thereby has been properly aligned and plumbed.

Some field connections are still made with hot-driven rivets. Before riveting, the members are aligned and matching holes brought into matching position with drift pins. Drift pins are tapered steel rods which are driven into one or more pairs of matching holes in two members, forcing the parts into position with respect to each other. The parts are held together rigidly while the rivets are driven with either compression or manually operated power riveters. After driving, the rivets must be tight with their heads in full contact with the steel surface. Drifting during assembly should not distort or enlarge holes. Holes that need to be enlarged to admit rivets or bolts are reamed to an acceptable size. After rivets have been driven into all open holes, the drift pins are removed and replaced with the final rivets. Hot-driven rivets are usually heated uniformly to a temperature approaching 1950°F, and are driven before their temperature falls below 1000°F.

Most contemporary structural designs require field connections to be made with high-strength bolts or by welding. Bolted members are aligned with drift pins, in the same manner as riveted connections. Members to be welded are usually aligned with welded clips and wedges. "Come-a-longs" (portable geared wrenches with steel cables) are generally used to assist in alignment and positioning, regardless of the method of connection.

High strength bolted members must fit solidly together when assembled and not be separated by gaskets or any other compressible materials. The surfaces of high strength bolted parts in contact with the bolt head and nut must not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Beveled washers must be used to compensate for any lack of parallelism exceeding this value.

High strength bolts must be tightened to a bolt tension not less than that shown in Table 29-2-6. Tightening must be done precisely with the turn-of-nut method, or with properly calibrated wrenches.

TABLE 29-2-6. Tightening Tension Requirements for High Strength Bolts

Bolt Size, Inches	Minimum Bolt Tension,[1] Kips[2]	
	A325 Bolts	A490 Bolts
1/2	12	15
5/8	19	24
3/4	28	35
7/8	39	49
1	51	64
1 1/8	56	80
1 1/4	71	102
1 3/8	85	121
1 1/2	103	148
Over 1 1/2		0.7 x T.S.

[1] Equal to 70 percent of specified minimum tensile strengths of bolts, rounded off to the nearest kip.

[2] Kips: 1 Kip = 1,000 lbs. deadweight load.

When the turn-of-nut method is used to provide the bolt tension as specified in Table 29-2-6, sufficient bolts in the connection are first tightened to a "snug fit" condition to assure that the parts of the joint are brought into intimate contact with each other. Snug fit is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following the initial tightening, bolts are placed in any remaining holes in the connection and brought to "snug tightness". All bolts in the connection are then

tightened additionally by the applicable amount of nut rotation specified in Table 29-2-7, with the tightening progressing systematically from the most rigid part of the joint to its free edges. During the tightening operation, either the bolt or the nut may be rotated, but the other part must remain stationary.

TABLE 29-2-7. Nut Rotation From Snug Tight Condition

Disposition of Outer Faces of Bolted Parts		
Both faces normal to bolt axis, or one face normal to axis and other face sloped nor more than 1:20 (bevel washer not used)		Both faces sloped not more than 1:20 from normal to bolt axis (bevel washers not used)
Bolt length[b] not exceeding 8 diameters or 8 inches	Bolt length[b] exceeding 8 diameters or 8 inches	For all length of bolts
1/2 turn	2/3 turn	3/4 turn

[a] Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation: 30° over or under. For coarse thread heavy hex structural bolts of all sizes and length and heavy hex semi-finished nuts

[b] Bolt length is measured from underside of head to extreme end of point.

When calibrated wrenches (power or manual) are used for bolt tensioning, their setting should be such as to induce a bolt tension 5% to 10% in excess of the value specified in Table 29-2-6. Each calibrated wrench used should be re-calibrated at least once each working day by tightening at least three representative bolts of each diameter being installed, in a device capable of indicating actual bolt tension. Power wrenches should be adjusted to stall or cut-out at the desired tension. When manual torque wrenches

are used, the torque indication corresponding to the calibrating tension should be noted and used in the installation of all bolts of the tested lot.

The bolt-tightening procedures described herein are industry-accepted methods specified by the American Institute of Steel Construction (AISC) and published in the Manual of Steel Construction by that organization.

When structural steel work is designed with welded connections, welding work is usually specified to be performed in accordance with the American Welding Society (AWS) specification D.1.1, Structural Welding Code. The welding processes used and the code requirements are the subject of other courses* and are not covered in this Module.

* Nuclear Technology, Course 28, Welding Inspection

INSPECTION OPERATIONS

General

In most structural steel installation/erection projects, little or no testing is done. Testing is normally performed by the material manufacturers, who provide test reports of chemical and physical test results, or certificates of conformance to material specification requirements to the material purchasers upon request.

Inspection of the materials and the various erection operations by QA/QC technicians or inspectors, however, is usually performed, particularly on nuclear power plant projects.

Receiving Inspection

Inspection begins with the receipt inspection of materials at the job site before use. Materials such as rolled steel shapes, fabricated components, high-strength bolts, rivets and weld filler metal, are usually required to be examined for such characteristics as (1) proper identification, (2) correct size and grade, and (3) freedom from damage incurred in shipping and storage. When ordered to particular specification requirements, such as ASTM, the materials may be inspected for conformance to all applicable criteria. When materials are furnished with material test reports, the reported test results are compared with the applicable specification requirements to determine the acceptability of the materials. When found to be acceptable, the materials are released for construction use. When found to be unacceptable (nonconforming to specification requirements) the materials may be dispositioned in one of several ways: (1) rejected and removed from the job site, (2) rejected for the intended use, but approved for use (by the architect-engineer) in a different application where acceptable, or (3) re-evaluated (by the architect-engineer) and approved for use "as-is".

Receipt-inspection activities are fully documented. Reports include the following information.

- Date received
- Purchase order reference
- Specification requirements reference
- Quantities and description of material received
- Description of attributes examined & acceptance criteria
- Inspection results
- Accept/reject decision for each item examined

- Disposition of material (released for use, removed from job site, etc.)
- Signature of inspector and date inspected

Site Inspection

Before actual erection work begins, the erection site is inspected. Columns are usually the first members to be set and it is normally required that the column foundations be inspected for the following characteristics:

- Correct foundation location and size
- Concrete adequately cured
- Embedded anchor bolts: correct size, number, location and configuration; bolts free from rust, concrete spatter or thread damage.

As erection proceeds, columns are plumbed, temporarily braced, and bolted in place. The following items should be inspected:

- Column member identification (verify that correct part is being used)
- Correct orientation and alignment
- Proper anchor bolt tightness
- Column plumb, within tolerance
- Column elevation correct

When a sufficient number of columns have been set, inspected and approved to support subsequent erection work, cross members (beams, joints, etc.) and permanent brace members are installed. It is suggested that general surveillance inspection of these operations be performed during the erection and fastening work to verify the following:

- Correct members are installed at each specified location
- Member orientation and alignment is correct

- Correct fastening materials and methods are used:
  Bolting - Correct size and type used. Washers used as required. Proper torquing method and value used. Bolts installed in all holes.
  Rivets - Correct size and type used. Rivets driven to tight, full contact condition. Rivets installed in all holes.
  Welding - Correct procedure used. Joint preparation acceptable. Correct filler metal (type and size) used. Welding technique and finished results acceptable. Welder qualified.
- Acceptable rigging and handling methods used, to preclude damage to structural members.

Final Inspection

On many projects, after the completion of bolt tightening operations, it is a requirement to inspect and verify that the tightening work is acceptable. This is done by applying the required torque, in the tightening direction and with a calibrated torque wrench, to 10% of the bolts, but not less than two bolts, selected at random in each connection. If no nut or bolt head is turned by this application of force, the connection is accepted as properly tightened. If any nut or bolt head is turned by the application of this force, this torque is applied to all bolts in the connection.

The final inspection of the erection work should include a random check of all of the aforementioned items and:

- Check final painting, coating and retouch work, as required by the job specifications.
- Check removal of all temporary bracing, scaffolding, safety nets, and contractor's materials and equipment from the area.
- Check completed condition of all connections.

Documentation

All inspections performed should be documented. Standard report forms are usually developed for each project, and may include check lists to guide the inspector in covering all required areas and operations. In general, the inspection reports should include:

- Identification of parts, joints, area, elevation, etc.
- Attributes or activities inspected
- Description of findings
- Specific accept/reject decisions
- Inspector's signature and date of inspection

Summary of Inspection

The following list summarizes the items that are typically checked or inspected during the various structural steel erection/installation operations:

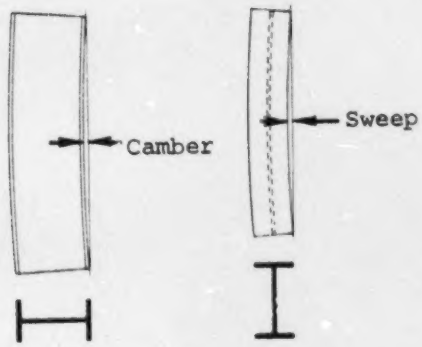
- Material grade and acceptability
- Prefabricated member shape, size and condition
- Shop-coating acceptable condition
- Bolt-hole lay-out and sizes
- Acceptable foundation preparations
- Contractor's steel materials handling and erection methods and equipment
- Plumbing and bolt tightening operations
- Field welding operations when applicable (weld filler materials, joint preparation, weld procedures, welder's qualifications and certifications)
- Calibration of bolt-tensioning equipment
- Inspection of finished bolted connections
- Documentation (material test reports, inspection reports, test reports, etc.)

A steel supplier has submitted test reports for samples of steel representing three lots of ASTM A36 steel shapes and three lots of ASTM A529 steel shapes. The values reported for the various required characteristics are shown below. Evaluate the reported values using Subject Matter of this module and circle all out-of-tolerance conditions.

ASTM A36 Steel Samples	Sample 1	Sample 2	Sample 3
Chemical Composition			
Carbon, %	0.252	0.238	0.271
Phosphorous, %	0.027	0.254	0.327
Sulfur, %	0.038	0.029	0.041
Physical Properties			
Tensile strength, psi	58,200	66,700	73,900
Yield point, psi	33,900	39,200	41,200
Elongation in 8 in.,%	18.9	22.7	23.2
Elongation in 2 in.,%	20.3	22.9	24.6

ASTM A529 Steel Samples	Sample 4	Sample 5	Sample 6
Chemical Composition			
Carbon, %	0.291	0.258	0.261
Manganese, %	0.073	1.021	1.319
Phosphorous, %	0.033	0.053	0.029
Sulfur, %	0.041	0.039	0.042
Physical Properties			
Tensile strength, psi	64,800	72,800	79,500
Yield point, psi	40,800	46,700	49,900
Elongation in 8 in., %	20.8	17.3	22.1

A group of 10 - 6" (nominal) "S" beams has been purchased to ASTM A6 straightness requirements. The applicable ASTM A6 requirements (for straightness) are shown below:



ASTM A6 Permissible Variations in Straightness for Beam (S and M Shapes)

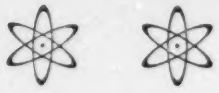
Variable	Nominal Size, in.	Permissible variation, in.
Camber	under 3	1/4 in. in any 5 ft, or 1/4 x (number of feet of total length/5)
	3 and over	1/8 x (number of feet of total length/5)
Sweep	all	Due to the extreme variations in flexibility of these shapes, straightness tolerances for sweep are subject to negotiations between the manufacturer and the purchaser for the indiviual sections involved.

[a] Greatest cross-sectional dimension.

Positions for Measuring Camber and Sweep

The parts are identified by number and length, and inspected for straightness (camber). For each of the parts listed below, (a) calculate the permissible variation in camber, and (b) indicate accept/reject disposition of each part:

Part No.	Length, ft.	Measured Camber, in.	(a) Calculated Permissible Camber, in.	(b) Disposition Accept/Reject
1	10	3/16	_____	_____
2	15	1/2	_____	_____
3	15	1/4	_____	_____
4	20	11/16	_____	_____
5	25	9/16	_____	_____
6	35	5/8	_____	_____
7	30	13/16	_____	_____
8	20	5/8	_____	_____
9	20	7/16	_____	_____
10	5	3/32	_____	_____



EXERCISES

1. Tour a construction site involved with steel erection as indicated in the Procedures section of this module. Take notes on the Data Table 29-2-1 on page 29-2-24 as given in the Data Table section of this module.

2. List the basic structural members of roof support systems employing structural steel materials.

3. Discuss the methods of cutting steel parts and preparing bolt holes in structural steel members.

4. Explain the purpose of applying temporary protective coatings on structural steel members.

5. What are other methods of alignment used for erection of structural steel members?

6. Briefly discuss the use of drift pins in steel erection.

7. Describe the receipt-inspection operations including:
   a. basic examinations performed
   b. purpose of test reports
   c. acceptability of material test reports

8. What is meant by the "Turn-of-nut" method of bolt tensioning?

9. Discuss the final inspection of bolted fasteners including sample size and actions taken when acceptance criteria are not met.

MATERIALS

None.

PROCEDURES

1. Tour a construction site involved with steel erection. The tour should be guided by a construction supervisor knowledgeable of inspection activities. Take notes on Data Table 29-2-1.
2. Discuss in class notes of the construction site tour.

DATA TABLE

Data Table 29-2-1
Tour of Construction Site

Site: _____

Construction Contractor: _____

Inspection Agency: _____

Bolting Operations:

- Bolt Identification _____
- Nut Identification _____
- Method of Alignment _____
- Method of Torquing _____
- Inspection _____

Riveting Operations:

- Rivet Identification _____
- Method of Alignment _____
- Inspections _____

Welding Operations:

- Joint Preparation _____
- Welding Process _____
- Inspections _____

Material Storage:

- Description: _____

REFERENCE MATERIALS

AISC, Manual of Steel Construction, American Institute of Steel Construction

Parker, Harry & Hauf, Harold D., Simplified Design of Structural Steel, Wiley-Interscience

AISC, Quality Criteria and Inspection Standards, American Institute of Steel Construction

Marcus, Samuel H., Basics of Structural Steel Design, Reston

TEST

1. List the basic structural components of roof support systems:
   a.
   b.

2. Name two methods of cutting parts from steel plate material:
   a._____
   b._____

3. State the purpose of reaming of punched or drilled holes in steel connections.

4. State the purpose of coatings applied to steel members.

5. Describe storage conditions at the job site for:
   a. Uncoated prefabricated steel members

   b. Coated prefabricated steel members

6. Describe the use of drift pins in steel erection.

7. State the typical temperature limits for rivet hot-driving operations.

8. State the purpose of bevel washers for bolted connections.

9. Describe the turn-of-nut method of bolt tensioning.

10. Name the specification which governs structural welding work.

11. State the three basic examinations performed during receipt inspection of materials.

12. State the purpose of material test reports and briefly describe how the acceptability of such reports is determined.

13. If a bolted steel connection contains sixteen bolts, how many bolts are tested for tightness.

14. If one of the bolts turns when testing bolted connections for tightness, what steps are taken?